Geophysical Research Abstracts
Vol. 18, EGU2016-9256, 2016
EGU General Assembly 2016

Support Vector Machine Model for Automatic Detection and Classification of Seismic Events

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The automated processing of multiple seismic signals to detect, localize and classify seismic events is a central tool in both natural hazards monitoring and nuclear treaty verification. However, false detections and missed detections caused by station noise and incorrect classification of arrivals are still an issue and the events are often unclassified or poorly classified. Thus, machine learning techniques can be used in automatic processing for classifying the huge database of seismic recordings and provide more confidence in the final output.

Applied in the context of the International Monitoring System (IMS) - a global sensor network developed for the Comprehensive Nuclear-Test-Ban Treaty (CTBT) - we propose a fully automatic method for seismic event detection and classification based on a supervised pattern recognition technique called the Support Vector Machine (SVM). According to Kortström et al., 2015, the advantages of using SVM are handleability of large number of features and effectiveness in high dimensional spaces. Our objective is to detect seismic events from one IMS seismic station located in an area of high seismicity and mining activity and classify them as earthquakes or quarry blasts. It is expected to create a flexible and easily adjustable SVM method that can be applied in different regions and datasets. Taken a step further, accurate results for seismic stations could lead to a modification of the model and its parameters to make it applicable to other waveform technologies used to monitor nuclear explosions such as infrasound and hydroacoustic waveforms.

As an authorized user, we have direct access to all IMS data and bulletins through a secure signatory account. A set of significant seismic waveforms containing different types of events (e.g. earthquake, quarry blasts) and noise is being analysed to train the model and learn the typical pattern of the signal from these events. Moreover, comparing the performance of the support-vector network to various classical learning algorithms used before in seismic detection and classification is an essential final step to analyze the advantages and disadvantages of the model.